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Harmon

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(54) **ASPHALT SHINGLE RECYCLING SYSTEM AND METHOD**

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(51) **Int. Cl.**
B02C 19/00 (2006.01)

(52) **U.S. Cl.** **241/21**; 241/23; 241/25

(58) **Field of Classification Search** 241/101.8, 241/23, 25, 29, 21; 106/273.1; 366/24
See application file for complete search history.

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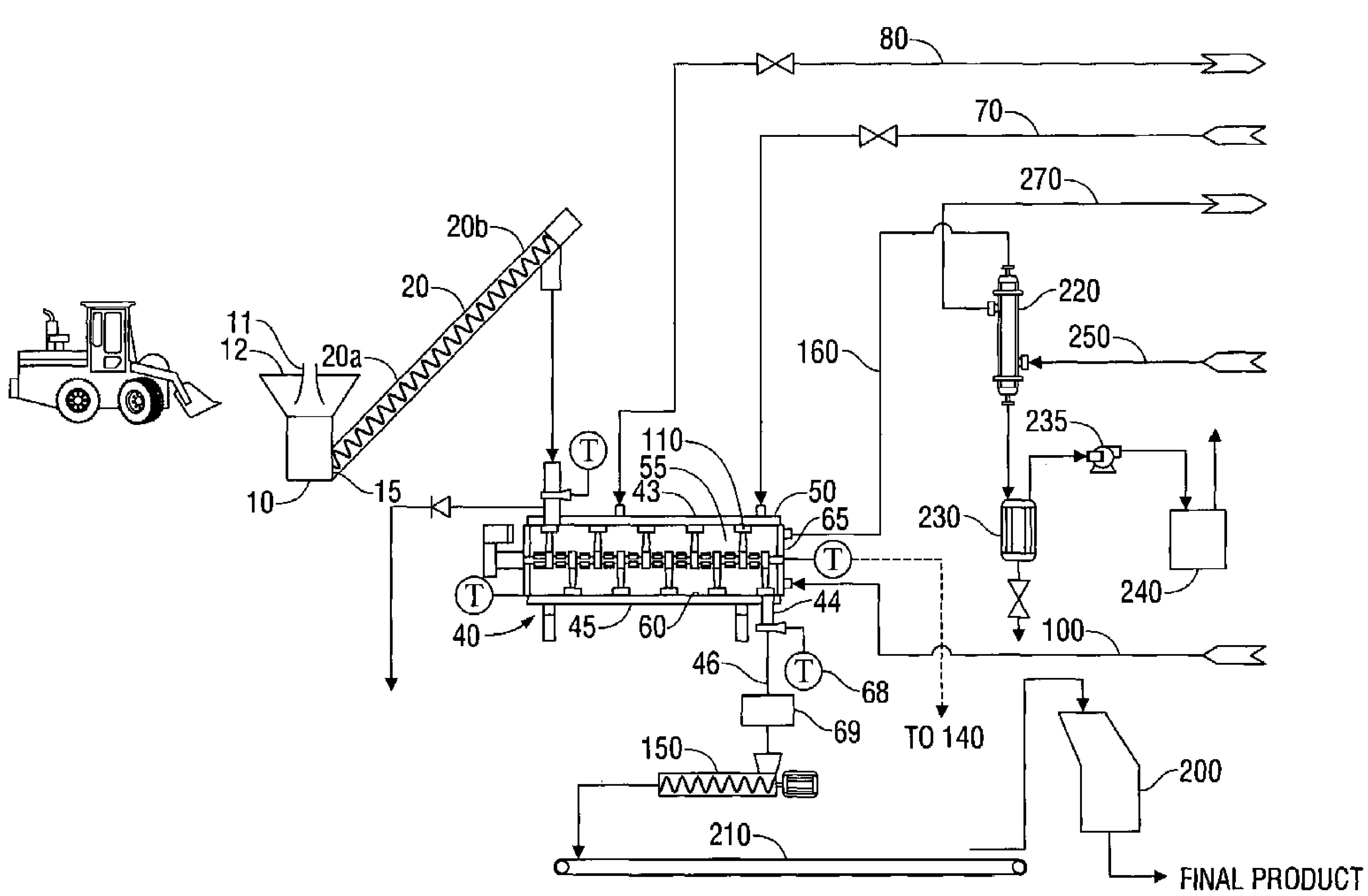
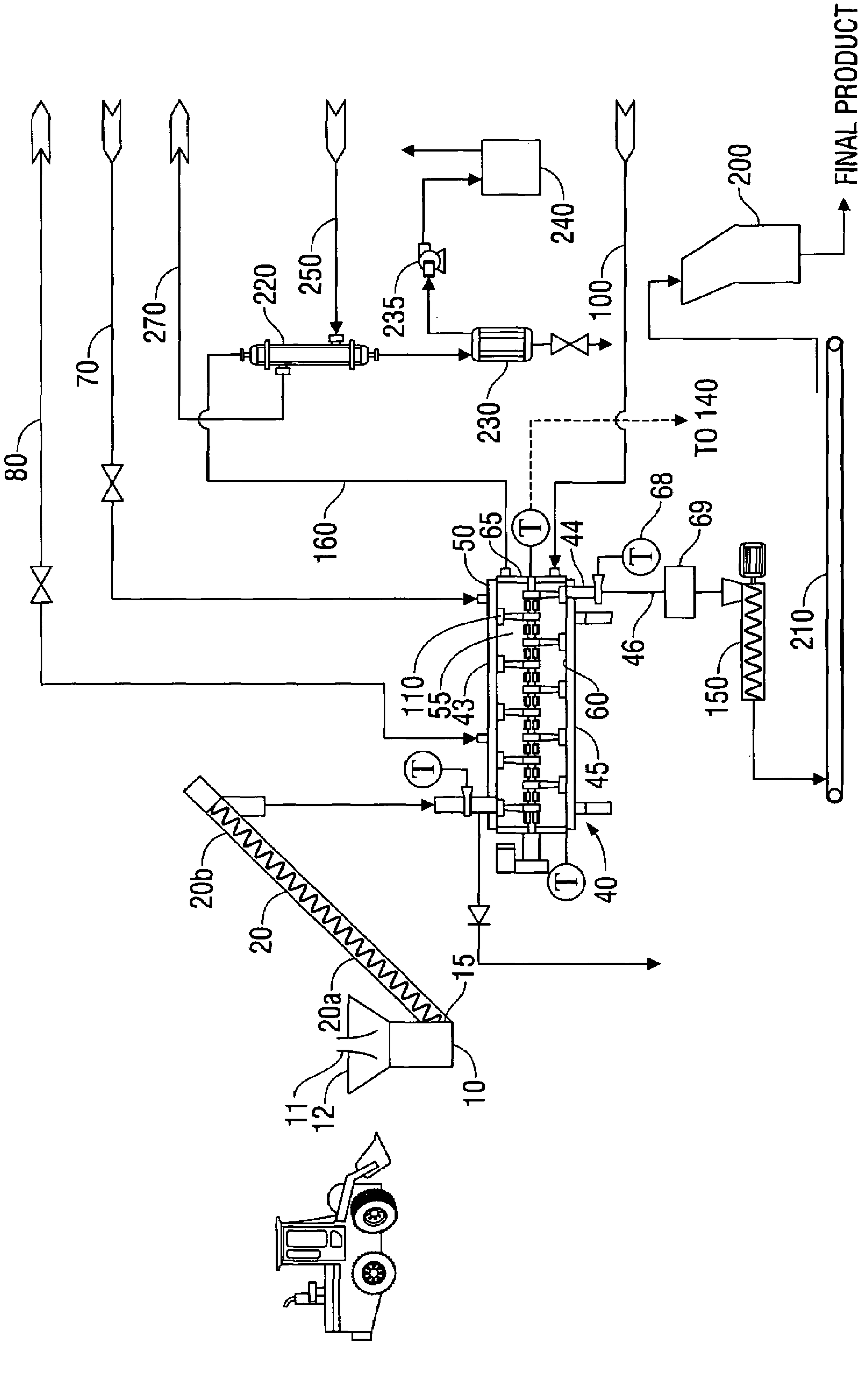
Primary Examiner — Mark Rosenbaum

(57) **ABSTRACT**

The asphalt roofing material is delivered into a treatment chamber of a processor. Hot oil is passed through a jacket surrounding the treatment chamber. Heated asphalt forms a hot solid and/or a liquefied slurry. The hot solid and/or the liquefied slurry is then removed from the treatment chamber. The asphalt roofing material in the treatment chamber can be agitated to promote mixing. The asphalt is heated to a temperature in the range from 200 degrees Fahrenheit to 650 degrees Fahrenheit within the treatment chamber. The solid and/or liquefied slurry is milled after it has been removed from the treatment chamber. The solid and/or the liquefied slurry is cooled after it exits the treatment chamber, preferably to a temperature in the range of approximately 90 degrees Fahrenheit to 110 degrees Fahrenheit. The hot solid and/or the liquefied slurry is passed through a hammer mill after the hot solid and/or the liquefied slurry exits the treatment chamber to reduce the particle size of the solid particles.

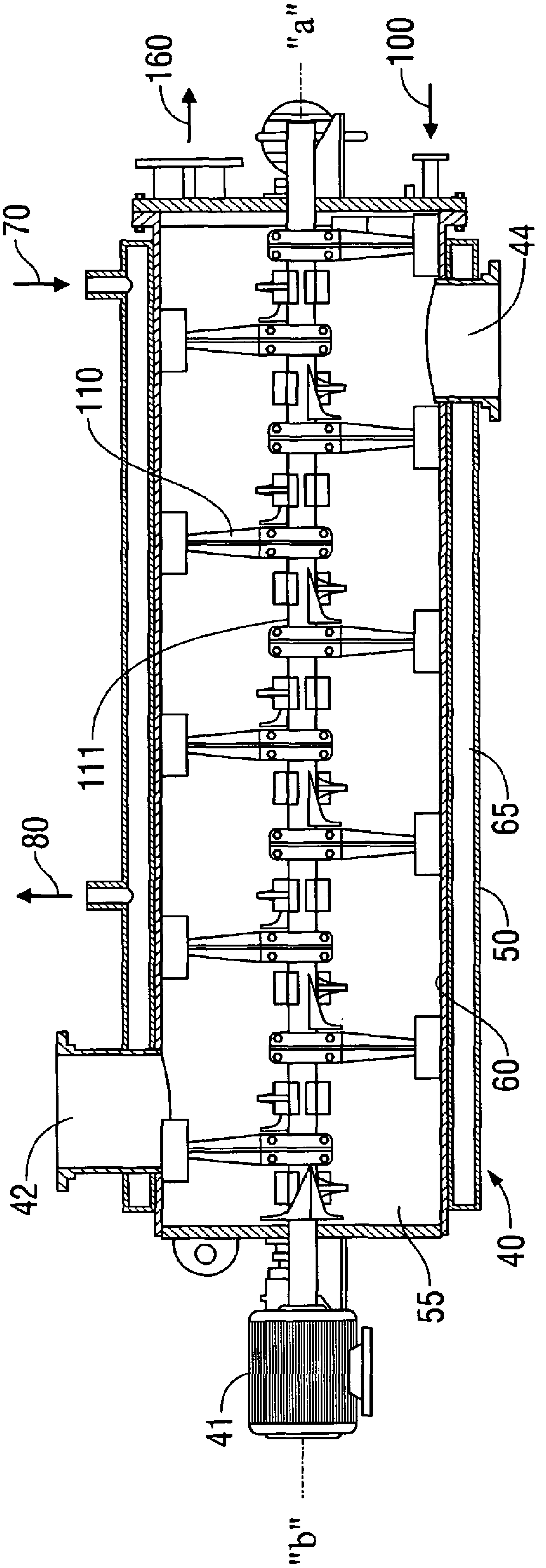
10 Claims, 4 Drawing Sheets





FINAL PRODUCT
TO 140
T
10
11
12
15
20
20a
20b
40
43
44
45
46
50
55
60
65
68
69
70
80
100
110
150
160
200
210
220
230
235
240
250
270

FIG. 1


"a"
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100
70
44
110
111
80
42
65
50
60
40
55
41
"b"

FIG. 2

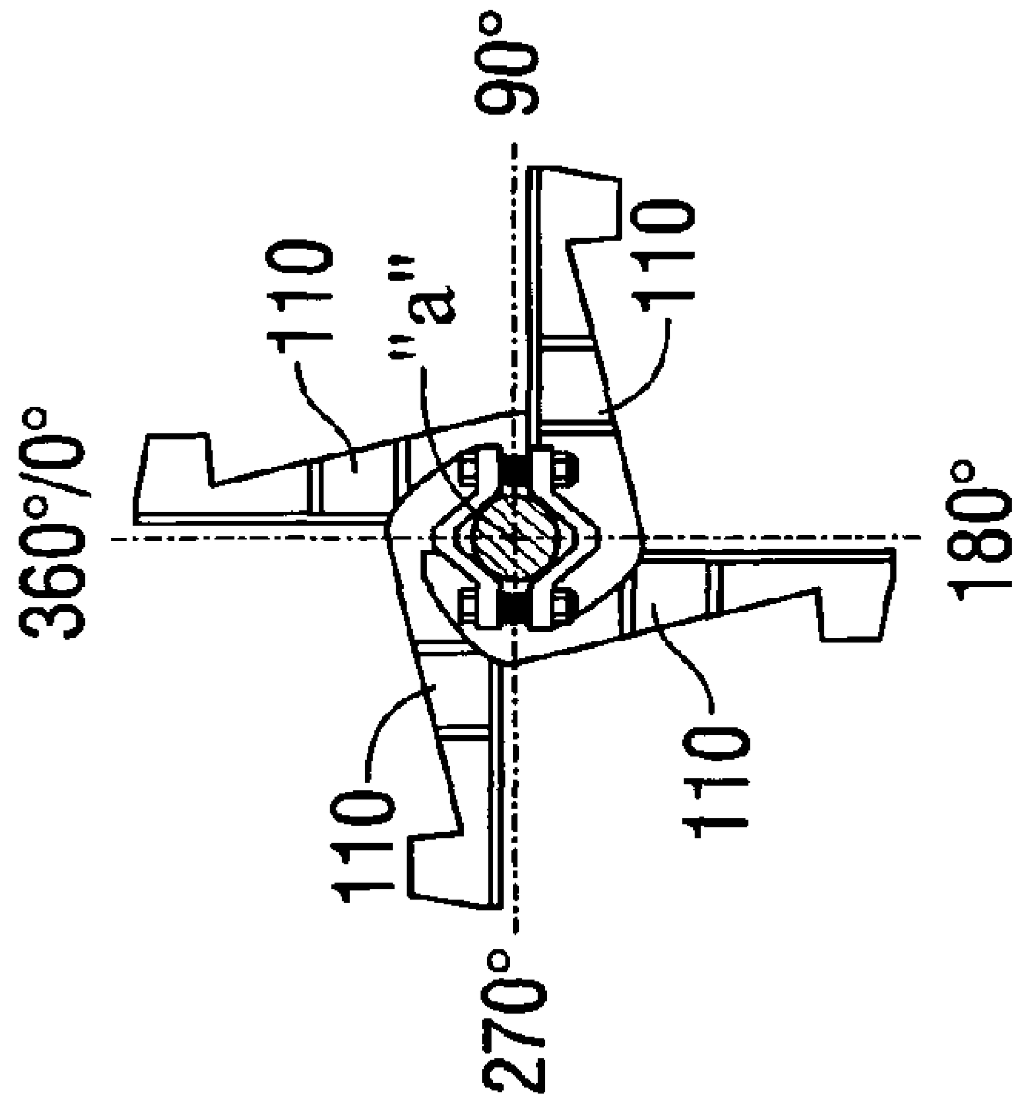
90°
110
110
"a"
360°/0°
180°
110
110
270°

FIG. 3

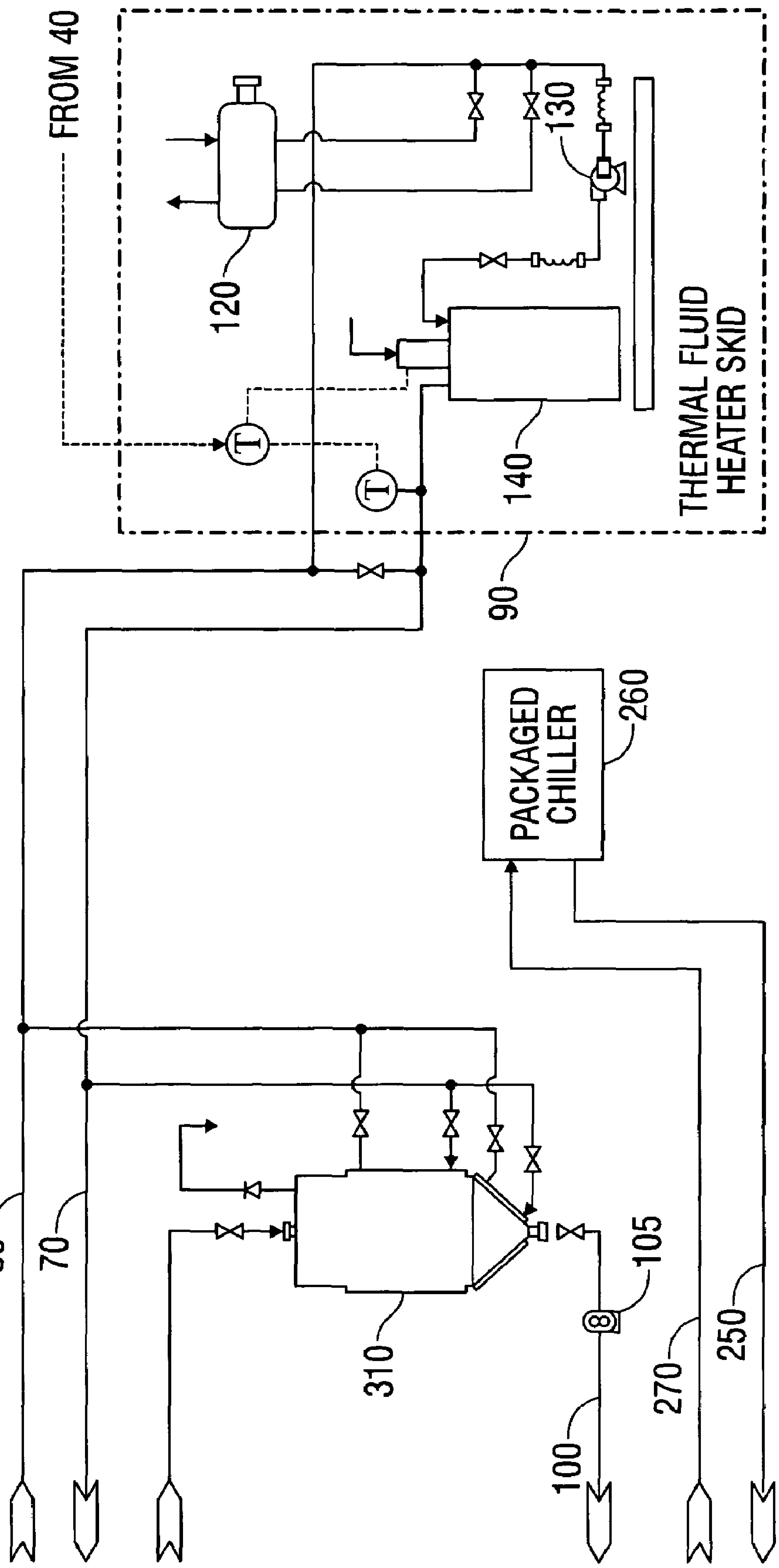
FROM 40
120
130
140
T
T
THERMAL FLUID
HEATER SKID
90
PACKAGED
CHILLER
260
80
70
310
105
100
270
250

FIG. 4

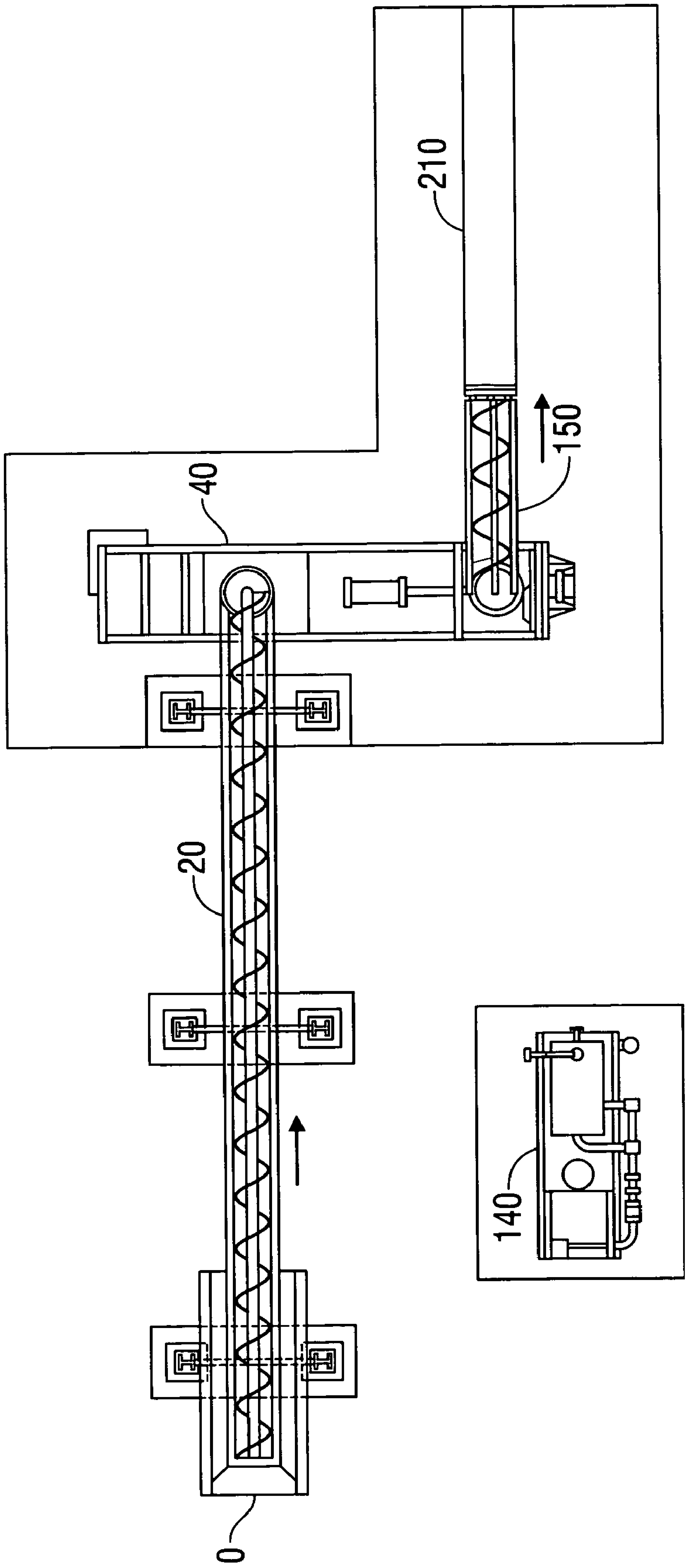

FIG. 5

ASPHALT SHINGLE RECYCLING SYSTEM AND METHOD

RELATED APPLICATION

This application claims priority from U.S. Provisional Patent Application Ser. No. 61/069,435, filed on Mar. 14, 2008, for ASPHALT SHINGLE RECYCLING SYSTEM AND METHOD.

BACKGROUND

1. Field of Invention

The invention relates generally to recycling of asphalt shingles, and in particular, to a system and method for recycling of asphalt shingles utilizing heat treatment.

2. Description of Art

Asphalt concrete pavement is commonly used in roadway construction. The asphalt concrete pavement typically comprises liquid asphalt cement combined with aggregate. The aggregate is usually a mixture of sand, gravel, and stone. The aggregate and liquid asphalt cement are mixed and heated to form an asphalt paving composition. The crushed gravel and stone particles of the aggregate provide sharp edges which, when combined with the liquid asphalt cement, create an aggregate interlock which improves the strength of the composition.

Liquid asphalt cement can be expensive. Shredded asphalt roofing shingles are often used as a substitute for liquid asphalt cement. The asphalt roofing shingles are sometimes "recycled" and incorporated into the asphalt pavement composition.

It is difficult to regulate the consistency of the asphalt pavement composition produced by existing recycling processes. Also, air emissions from existing recycling processes can be detrimental to the atmosphere.

SUMMARY OF THE INVENTION

In accordance with the illustrative embodiments hereinafter described, a system and method for recycling asphalt roofing shingles is described. Scrap and tear-off shingles from roofing materials are heat treated to form a hot solid and/or liquefied to produce a slurry that can be formed into a finished product. The content of the hot solid or liquid slurry can be regulated with a relatively high degree of consistency. Further, many of the air emission concerns that existed in previous asphalt shingle recycling processes are eliminated.

In one particular embodiment, a method of recycling asphalt roofing material is provided. The asphalt roofing material is delivered into a treatment chamber of a processor. A heat source is passed through a jacket that at least partially surrounds the treatment chamber. Heat energy is transferred from the heat source to the asphalt roofing material until the asphalt roofing material forms a hot solid or a liquefied slurry. The liquefied slurry or the hot solid is then removed from the treatment chamber. Heated oil can be used as the heat source. Asphalt can be added to the asphalt roofing material if desired. The asphalt roofing material in the treatment chamber can be agitated to promote mixing. The asphalt roofing material can be heated to a temperature in the range from 200 degrees Fahrenheit to 650 degrees Fahrenheit, preferably to about 350 degrees Fahrenheit within the treatment chamber. The liquefied slurry or the hot solid can be milled after it has been removed from the treatment chamber to form a final recycled product. The liquefied slurry or the hot solid can be cooled after it exits the treatment chamber, preferably to a temperature in the range of approximately 90 degrees Fahrenheit to 110 degrees Fahrenheit. The liquefied slurry or the hot solid can be passed through a hammer mill after the liquefied slurry or the hot solid exits the treatment chamber.

In another aspect, a processor for recycling asphalt roofing material is provided. The processor can include a treatment chamber, an inlet disposed on the treatment chamber for allowing untreated asphalt roofing material to enter the treatment chamber, an outlet disposed on the treatment chamber for allowing treated asphalt roofing material to exit the treatment chamber, and a jacket at least partially surrounding the treatment chamber, the jacket having a outer wall, an inner wall, and a passageway therebetween for allowing a heat source to pass therethrough. A feature of the processor is that an agitator arm can be disposed within the treatment chamber. The agitator arm can have a shaft and one or more paddles positioned thereon that contact the contents of the treatment chamber. A screw conveyer can be disposed adjacent to the inlet for delivering untreated asphalt roofing material to the treatment chamber. The screw conveyer can include a plurality of variable speed conveyors for regulating the flow of untreated asphalt roofing material to the treatment chamber, The heat source can be heated oil, and the heated oil can circulate through the jacket.

In another aspect, an apparatus for recycling asphalt roofing material is provided. The apparatus can include a jacketed agitated processor for heating the asphalt roofing material to produce either a hot solid or a partially or completely liquefied product, a heating skid for supplying a heat source to the jacket of the agitated processor, and a hammer mill for reducing the particle size of solid particles present in the hot solid or the partially liquefied product. The apparatus can also include a sizing unit for reducing the particle size of solid particles present in the hot solid or the partially liquefied product before the hot solid or the partially liquefied product is delivered to the hammer mill. A screw conveyer can be utilized for delivering asphalt roofing material to the processor. The screw conveyer can include a plurality of variable speed conveyors for regulating the flow of untreated asphalt roofing material to the treatment chamber. One or more temperature measuring devices can be disposed at the outlet of the jacketed agitated processor. Further, one or more cooling devices can be positioned between the outlet of the jacketed agitated processor and the inlet of the hammer mill for measuring and regulating temperature at the processor outlet.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic side view of equipment utilized in a specific embodiment of an asphalt shingle recycling system and method according to the invention.

FIG. **2** is a schematic side view of a processor utilized in a specific embodiment of an asphalt shingle recycling system and method according to the invention.

FIG. **3** is a schematic top view of an agitator arm and a plurality of paddles utilized in a specific embodiment of an asphalt shingle recycling system and method according to the invention.

FIG. **4** is a schematic side view of additional equipment utilized in a specific embodiment of an asphalt shingle recycling system and method according to the invention.

FIG. **5** is a schematic top view of additional equipment utilized in a specific embodiment of an asphalt shingle recycling system and method according to the invention.

DETAILED DESCRIPTION

Referring now to FIGS. **1-5**, a preferred illustrative embodiment of an asphalt roofing shingle recycling system and method is provided. Scrap asphalt shingles are collected and deposited in hopper **10**. Hopper **10** is preferably of carbon steel construction and has at least a three cubic yard storage capacity. Hopper **10** can also have hinged doors **11** at or near its top end **12** through which scrap asphalt shingles may be loaded.

The contents of hopper **10** can empty onto a screw conveyer **20** by opening bottom doors **13**. Screw conveyer **20** preferably has at least a ten ton-per-hour capacity and is driven by at least a sixty horsepower variable frequency drive ("VFD") motor.

Screw conveyer **20** delivers the scrap asphalt shingles from hopper **10** to processor **40**. In a preferred embodiment, processor **40** is formed of carbon steel, and includes an inlet **42** on its top end **43** for receiving the scrap asphalt shingles from screw conveyer **20**. If desired, temperature reading and moisture reading devices can be installed at or near inlet **42** to allow for monitoring by a process operator. Further, screw conveyer **20** can have a dual delivery system, if desired, to prevent clogging and to feed the asphalt shingles into processor **40** in an even and consistent manner. Shingles can be loaded into hopper **10** and then pulled from hopper **10** by a short variable speed conveyor **20***a* that feeds onto a longer variable speed conveyor **20***b*. By adjusting the speeds of the two conveyors **20***a* and **20***b*, the flow of shingles into processor **40** can be regulated which will reduce or eliminate clogging.

The scrap asphalt shingles are heated in a treatment chamber **55** disposed within processor **40** until the shingles are a hot solid or are at least partially liquefied. For example, a substantial portion of the scrap asphalt can take the form of a hot solid and/or a slurry after being heated in treatment chamber **55** of processor **40**.

Processor **40**, as illustrated in the embodiment of FIGS. **1&2**, is manufactured by the Dupps Company of Germantown, Ohio. Processor **40** was originally designed by the Dupps Company for rendering animal protein products. Processor **40** has been adapted according to embodiments of the present system and method to recycle asphalt shingles. For example, processor **40** can utilize hot oil instead of steam (as intended in animal protein rendering applications) as a heating source. Hot oil is preferably utilized as the heat supplying stream, due to its capacity for reaching higher temperatures than steam, although steam or other heat sources may also be utilized.

Jacket **65** at least partially surrounds processor **40**. Jacket **65** preferably comprises an outer wall **50** and an inner wall **60** with a passageway formed therebetween. The hot oil circulates within the passageway of jacket **65** and flows around the exterior of processor **40**. The hot oil delivers heat energy to the scrap asphalt shingles contained within treatment chamber **55** of processor **40**. Jacket **65** allows for transfer of heat over a larger surface area within processor **40** than, for example, isolated heating coils or tubes.

In an illustrative embodiment, the scrap asphalt shingles are heated to a temperature in the range from 200 degrees Fahrenheit to 650 degrees Fahrenheit, more preferably about 350 degrees Fahrenheit, within treatment chamber **55** of processor **40**. At these temperatures, the scrap asphalt shingles will at least partially liquefy to take the form of a slurry, which will allow the asphalt materials to flow more easily when they exit processor **40**. It should be appreciated that the use of temperatures less than 350 degrees Fahrenheit produces a hot solid, while temperatures greater than 350 degrees Fahrenheit tend to at least partially liquefy the asphalt. When it is time for the hot solid to exit the processor **40**, instead of using the slurry line **46**, an opening in the bottom of processor **40**, having the dimensions of 24 inches by 24 inches, is opened by using hinged doors (not illustrated) to allow the solid to exit the processor **40**.

The hot oil is initially stored in a heating tank **120**, as illustrated in FIG. **4**. Heating tank **120** is preferably associate with a thermal fluid heater skid **90**. Skid **90** also includes a supply pump **130** and expansion tank **140** associated with heating tank **120**. The hot oil is delivered to processor **40** via heat inlet stream **70** and exits processor **40** via heat outlet stream **80**, and is recirculated through skid **90**.

As an option, liquid asphalt additive can be added to the asphalt shingles in processor **40**. The liquid asphalt additive can be, for example, virgin non-oxidized asphalt. The liquid asphalt additive further enhances the asphalt shingles in processor **40**, and can affect other characteristics such as melt point. The liquid asphalt additive can be delivered to processor **40** via additive inlet stream **100** and pump **105**, as illustrated in FIG. **4**. The liquid asphalt additive can be heated in heater **310** prior to being introduced into processor **40**.

In an illustrative embodiment as shown in FIGS. **2-3**, the contents of treatment chamber **55** of processor **40** can be agitated in order to promote mixing. In a preferred embodiment, processor **40** includes a 75 horsepower motor **41** and an agitator arm **111** that is operationally connected to motor **41** and extends within processor **40**. One or more paddles **110** are positioned along the length of agitator arm **111**. Paddles **110** turn and contact the material within treatment chamber **55** of processor **40** as agitator arm **111** rotates to stir and mix the treatment chamber's contents until they are of the desired consistency. The shaft of agitator arm **111** can turn clockwise or counterclockwise (as viewed from the vantage point "a" on FIGS. **2-3**) within processor **40**. Preferably, shaft of agitator arm **111** turns clockwise during mixing and counterclockwise during discharge of the material from processor **40**, or vice versa.

In an illustrative embodiment, processor **40** preferably does not include any milling elements to grind, crush or abrade the scrap asphalt shingles during treatment therein, as these shingles will be adequately processed by heating and/or agitation alone. Further, it is not necessary for the scrap asphalt shingles to be shredded, milled or otherwise broken apart prior to treatment in processor **40**, or for liquid asphalt additive to be added to the contents of processor **40**.

In general, the viscosity and consistency of the mixture in processor **40** are controlled by the temperature and pressure within processor **40** and the amount of time the mixture is treated in processor **40**. The amount of liquid asphalt additive included in the mixture may also be a relevant factor, and may be varied, and adjusted as desired.

Upon heating, a certain portion of the asphalt mixture within processor **40** will take a gaseous/vapor form. This gas or vapor may also include steam or water vapor within processor **40**. A gas/vapor buildup within processor **40** could increase the pressure within processor **40** to undesirable levels. Vapor outlet stream **160** in FIG. **2** can be utilized to allow these gases/vapors to exit the top of processor **40**. Vapor outlet stream **160** is preferably directed to scrubber **220**, which condenses the gas/vapor stream to liquid form. Scrubber **220** in FIG. **1** is cooled by a recycled glycol stream **250** which is supplied by packaged chiller **260** in FIG. **4**. The glycol stream returns to packaged chiller via return stream **270**. The liquid from scrubber **220** is collected in receiver **230**. Alternatively, the vapor outlet stream can be cooled in a conventional cooling tower (not illustrated).

In a preferred illustrative embodiment, processor **40** includes an outlet **44** on its bottom end **45** whereby the hot solid and/or the heated scrap asphalt slurry can exit processor

40 via processor outlet stream **46** in FIG. **1**. If desired, one or more infrared temperature readers or other temperature measurement devices **68** can be positioned at or near outlet **44** of processor **40** to measure and/or monitor the temperature of the exiting scrap the hot solid or the asphalt slurry. If desired, a cooling device **69** can be utilized so that the temperature of the contents of processor **40** in outlet stream **46** can be reduced such as, for example, in elevated summer temperatures. In an illustrative embodiment, cooling device **69** can accept heated shingles in the range of approximately 260 degrees F. to 280 degrees Fahrenheit and cool them down to the range of approximately 90 degrees Fahrenheit to 110 degrees Fahrenheit. Cooling device **69** can utilize water mist, fans and/or tumbling action to cool the shingles, although other cooling means may also be utilized.

Processor outlet stream **46** is ultimately directed from processor **40** to sizing unit **150**. Sizing unit **150** preferably includes a 75 horsepower VFD motor and can accommodate 10,000 pounds or more per hour of materials. In a preferred embodiment, sizing unit **150** is utilized to remove any thick asphalt or other solid materials that remain in processor outlet stream **46**.

After treatment in sizing unit **150**, the hot solid or the heated scrap asphalt slurry is delivered to hammer mill **200** via a belt conveyer **210**. Hammer mill **200** preferably includes a totally enclosed fan cooled ("TEFC") motor and can accommodate 10,000 pounds per hour of materials. The hammer mill **200** reduces the asphalt into even smaller particles, preferably able to pass through a one inch screen, or even smaller. If desired, temperature reading and moisture reading devices can be installed at or near the inlet to hammer mill **200** to allow for monitoring by a process operator.

The particles in hammer mill **200** can be formed into a desired final product. For example, the final product can be extruded, formed into a pellet, or can have the consistency of coffee grounds. Further, the particles can be allowed to harden before entering hammer mill **200** and then crushed to size.

If desired, cooling device **69** can be positioned at the entrance of hammer mill **200** in addition to, or instead of at the exit of processor **40**, or alternatively, a plurality of cooling devices **69** may be utilized in the present system.

The final product can be utilized, for example, as an additive for pavement or roofing materials or as a raw material for shingle manufacturing. Additional screening, bagging and loading systems may be incorporated into the system, as necessary, depending upon the size of, and intended use for, the final product. In an embodiment, the bagging system is an automatic dual bagging system that allows for bagging at up to 20 tons per hour. Further, grease zerts can be installed on all bearings and other related items in the system to facilitate prolonged periods of use.

In the drawings and specification, there has been disclosed and described typical preferred illustrative embodiments of the invention, and although specific terms are employed, the terms are used in a descriptive sense only and not for purposes of limitation. It will be apparent that various modifications and changes can be made within the spirit and scope of the invention as described in the foregoing specification. Accordingly, the invention is therefore to be limited only by the scope of the appended claims.

What is claimed is:

1. A method of recycling asphalt roofing material, the method comprising the steps of:
- delivering the asphalt roofing material into a treatment chamber of a processor;
- passing a heat source through a jacket at least partially surrounding the treatment chamber;
- transferring heat energy from the heat source to the asphalt roofing material until the asphalt roofing material forms a liquefied slurry;
- removing the liquefied slurry from the treatment chamber;
- cooling said liquefied slurry to thereby become at least a partial solid; and
- passing said at least partial solid through a hammer mill, thereby producing a dry granular recycled product.

2. The method of claim **1**, further comprising the step of utilizing heated oil as the heat source.

3. The method of claim **1**, further comprising the step of adding liquid asphalt to the asphalt roofing material in the treatment chamber.

4. The method of claim **1**, further comprising the step of agitating the asphalt roofing material in the treatment chamber.

5. The method of claim **1**, further comprising the step of heating the asphalt roofing material to a temperature in the range from 200 degrees Fahrenheit to 650 degrees Fahrenheit within the treatment chamber.

6. The method according to claim **5**, wherein the temperature within the treatment chamber is about 350 degrees Fahrenheit.

7. The method of claim **1**, further comprising the step of cooling the liquefied slurry to the range of approximately 90 degrees Fahrenheit to 110 degrees Fahrenheit.

8. A method of recycling asphalt roofing material, the method comprising the steps of:
- delivering the asphalt roofing material into a treatment chamber of a processor;
- passing a heat source through a jacket at least partially surrounding the treatment chamber;
- transferring heat energy from the heat source to the asphalt roofing material at a temperature of greater that 200 degrees Fahrenheit but less than the temperature which would liquefy the asphalt roofing material, thereby creating and maintaining the asphalt roofing material as a hot solid;
- removing the hot solid from the treatment chamber;
- cooling the solid product; and
- passing the solid product to a hammer mill to produce dry granular recycled asphalt products.

9. The method of claim **8**, further comprising the step of utilizing heated oil as the heat source.

10. The method of claim **8**, further comprising the step of cooling the hot solid to the range of approximately 90 degrees Fahrenheit to 110 degrees Fahrenheit.

* * * * *